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PHYTOTOXICOLOGY ASSESSMENT SURVEY INVESTIGATION IN THE VICINITY OF THE CANADIAN SALT COMPANY, WINDSOR-1989

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Background

Since 1976, the Phytotoxicology Section has conducted regular vegetation surveillance investigations in the vicinity of Morterm Limited in Windsor, Ontario. Morterm is a port terminal on the Detroit River which handles a variety of commodities, including bulk fluorspar. The purpose of the surveys has been to determine the impact of fluoride on the environment as a result of handling the fluorspar at the terminal.

Approximately 1.5 km south of Morterm, The Canadian Salt Company Limited operates a salt mining facility. Mined salts are customarily stored in large open piles on the property prior to being shipped to market. Although no formal survey was conducted around the salt facility, grasses collected as part of the Morterm survey since 1979, have been analyzed to determine concentrations of the salt components - sodium and chloride. Results of the previous surveys have indicated that values to these two elements in grasses collected at sites close to the salt facility were somewhat elevated, but that the area of influence was relatively small.

Prior to the 1989 field season, the Phytotoxicology Section received an official request from the Ministry's Windsor district office to conduct a more comprehensive surveillance of vegetation and soil in the vicinity of the mine.

Phytotoxicology Surveillance

On 19 September 1989, G. Vasiloff of the Phytotoxicology Section visited the area and conducted a grass and soil surveillance incorporating both Morterm Ltd. and The Canadian Salt Company Ltd. In order to accomplish this, 6 new sites were added to the existing 11 Morterm survey locations. Site 16 was designated as the new control location. The positions of the 17 surveillance sites in relation to the two companies are shown in Figure 1.

At each of the 17 survey sites, triplicate samples of grass and 0-5 cm soil were collected for chemical analysis. During the sampling procedures, vinyl gloves were worn by the field investigator to prevent sample contamination.

In addition, indigenous vegetation at each site was examined for visible evidence of salt-type injury. Results of these observations have been summarized in Table 1. No evidence of salt injury was observed at any location.

Collected grass and soil samples were submitted to the Phytotoxicology processing laboratory to be prepared according to standard procedures for chemical analysis. Processed samples were delivered to the Ministry's Inorganic Trace Contaminants laboratory to be analyzed for sodium and chloride.

Chemical Analysis Results - Grass

Sodium

Sodium values detected in grasses collected in 1989 at 17 sites in the vicinity of The Canadian Salt Company Ltd. appear in Table 2. Although grass samples collected at Sites 14 and 16 (control site), analytical results are not available. During the processing phase in the laboratory, identification labels for these samples were lost and, as a result, the samples were deemed unacceptable.

Sodium concentrations found in grasses at 11 sites from 1979 to 1986 have also been listed in the Table for comparison purposes. All-site, yearly mean values appear at the base of the Table.

Elevated values of sodium found in the 1989 grasses occurred in two separate areas - one relatively close to the salt company and the other approximately 2.5 km to the northeast. At the distant area, the survey maximum (1237 ppm) was detected at Site 9. At the adjacent Site 10, the sodium concentration, although much lower (330 ppm) than Site 9, was still much higher than the other sample sites to the northeast of the salt company.

Although the difference in sodium values found at the two distant sites (9 & 10) cannot be explained, it is not believed that the high sodium values detected at these sites are a result of emissions from Canadian Salt. If the company was the source, sodium values at intervening sites (2 & 6) would be much higher and a pattern of declining values with distance from the company would be evident - but such was not the case. This point is illustrated clearly in Figure 2.

Even though the sodium value at site 9 is much higher than at site 10, both are considered to be elevated. Since the salt company has been ruled out as a possible source, the high values at these two sites may have occurred as a result of the influence of road salt.

A computer-generated contour map (Surfer (TM), ver. 2.0), Kriging Method), was generated from the 1989 sodium data (Figure 2). The figure clearly illustrates the two separate areas with elevated sodium values in the grass samples. It is also clear that there is no apparent connection between the area of elevated sodium grass concentrations near the salt operation and the more distant area to the northeast.

With regard to emissions from the salt company, all-site mean values show that the sodium concentrations in grasses has varied considerably since 1979. The 1989 all-site mean of 238 ppm was higher than the 193 ppm of 1986, but considerably lower than 328 of 1985 or the 521 ppm of 1982. There has been no consistent trend in the survey mean-salt concentrations since 1979. Emissions from the salt operation are believed to be dependant upon levels of activity (storing, handling and shipping) and meteorological conditions (predominantly wind).

Chloride

Chloride values detected in grasses collected in 1989 and for the period from 1979 to 1986 are listed in Table 3. In similarity with the sodium data, elevated chloride values occurred in the same two areas, and likely for the same reasons. The two highest chloride values were found in grasses collected at Sites 10 (2.2%) and 9 (1.9%). Near the salt company, elevated chloride values were found in grasses at Sites 1 (1.6%), 13 (1.0%) and 17 (1.2%).

The computer-generated contour map (Figure 3), shows the two areas with elevated chloride values detected in the grasses and the lack of a concentration gradient between the salt company and the distant area.

Chemical Analysis Results - Soil

Sodium and Chloride

Sodium and chloride values detected in 0-5 cm soils collected in 1989 at 14 survey sites in the vicinity of the salt company appear in Table 4. A similar pattern of higher concentrations located in two separate areas was observed. The pattern of contamination was similar to the sodium and chloride concentrations detected in grass. The highest sodium and chloride values were at the sample sites farthest to the northeast, specifically 8 and 9. At Site 8 the sodium value was 108 ppm and the chloride value at Site 9 was 29 ppm. At the control site (16), sodium and chloride values were 66 ppm and 9 ppm, respectively. Only six of the 14 sample sites had sodium concentrations substantially higher than at the control site, whereas, 12 of the sites had elevated chloride levels.

At another group of sites near the salt company, sodium and chloride values were also found to be relatively elevated. Within this close-in group, elevated sodium values were found at Sites 3 (93 ppm), 2 (90 ppm) and 1 (86 ppm). Elevated chloride values were found at Site 14 (27 ppm), 17 (24 ppm), 15 (18 ppm), 1 (16 ppm) and 2 (15 ppm).

The soil sodium and chloride data were illustrated using the computer-generated contour maps (Figures 4 & 5). In relation to the salt company, the figures show one area of contamination close-in and another located much further away. The maps also demonstrate no apparent contamination gradient between the salt company and the elevated levels to the northeast.

Conclusions

Elevated values of sodium and chloride in grasses and soils were detected in two separate and distinct areas - one close to The Canadian Salt Company and another located approximately 2.5 km to the northeast. Computer-generated maps demonstrated that elevated values of both elements at distant sites were not connected with emission from the salt company. Road salt may be the origin of the distant contamination.

The sodium and chloride concentrations in grass were higher, on average, in 1989 than for any other year since the survey was initiated in 1979. However, the higher levels were the result of more severe contamination at sites 9 and 10, contamination which is not associated with the salt company.

Based on the contour maps, it is believed that The Canadian Salt Company was the source of the elevated sodium and chloride values detected in grasses and soil located close to the salt mining and storage operation. The area affected by the elevated values is relatively small. No evidence of visual injury to vegetation was observed at any of the survey sites.

It is believed that salt emissions from the company are related to the large, open piles of the material stored on the company property. The severity of emissions is likely related to frequency of product handling, size of inventory and meteorological conditions such as low humidity and wind speed.

TABLE: 1 Observational Notes of Vegetation Examined in the Vicinity of, The Canadian Salt Company Limited, Windsor - 1989

Map Survey Site Number	Direction & Approximate Distance from Salt Co.	Vegetation Examined	Visual Observations
1	0.6 km SSE	Wild grape	No visible salt injury.
		Sumac	Senescing. No salt injury.
2	0.4 km NNE	Willow	Crown 30% defoliated. No injury to remaining foliage.
		Goldenrod	No visible salt injury.
3	0.8 km ENE	Wild grape	No visible salt injury.
		Poplar	No visible salt injury.
4	1.5 km E	Wild grape	No visilbe salt injury.
		Dogwood	No visible salt injury.
5	1.6 km NNE	Wild grape	No visible salt injury.
		Sumac	No visible salt injury.
		Poplar	No visible salt injury.
6	1.5 km NE	Wild grape	No visible salt injury.
7	1.4 km NE	Wild grape	No visible salt injury.
8	2.1 km NE	Wild grape	No visible salt injury.
		Privet	No visible salt injury.
		Apple	No visible salt injury.
9	2.4 km NE	Wild grape	No visible salt injury.
		Poplar	No visible salt injury.
		Manitoba maple	No visible salt injury.
10	2.6 km NE	Wild grape	No visible salt injury.
		Manitoba maple	No visible salt injury.
11	1.6 km NNE	Wild grape	No visible salt injury.
		Poplar	No visible salt injury.
12	0.5 km S	Wild grape	Insect and disease symptoms. Senescing. No salt injury.
		Sumac	No visible salt injury.
		Mulberry	Fungal spots. Not salt injury.

...Cont'd

TABLE: 1 (Cont'd)

Map Survey Site Number	Direction Approximate Distance from Salt Co	Vegetation Examined	Visible Observations
13	1.2 km S	Wild grape	No visible salt injury.
		Sumac	Senescing. No salt injury.
		Sugar maple	No visible salt injury.
		Manitoba maple	No visible salt injury.
14	0.6 km SE	Wild grape	Insect injury symptoms. No visible salt injury.
		Sumac	Senescing. No salt injury.
		Mulberry	No visilbe salt injury.
15	1.2 km SE	Wild grape	Insect injury symptoms. No visible salt injury.
		Sumac	No visible salt injury.
		Poplar	No visible salt injury.
		Wild raspberry	No visilbe salt injury.
16 (Control)	2.2 km ESE	Wild grape	Insect & disease symptoms.
		Sumac	Insect injury symptoms. No visible salt injury.
		Privet	No visible salt injury.
		Soybeans	No visible salt injury.
17	1.0 km NNE	Wild grape	No visible salt injury.
		Wild raspberry	No visible salt injury.
		Mulberry	No visible salt injury.
		Mountain ash	No visible salt injury.

TABLE: 2 Sodium Content of Unwashed Grasses Collected Near The Canadian Salt Company Limited, Windsor 1979-1989

Survey Site Number	Sodium Concentration (ppm - dry weight)								
	1979	1980	1981	1982	1983	1984	1985	1986	1989
1	1520	1500	350	1260	661	993	513	343	443
2	182	270	150	480	180	570	1020	287	58
3	238	140	170	830	667	237	1167	953	170
4	77	105	83	440	71	87	160	93	58
5	111	NA	300	660	20	47	43	32	17
6	138	53	92	820	50	99	143	37	15
7	238	68	310	280	36	72	52	83	23
8	48	71	59	180	42	53	27	28	27
9	75	68	29	86	52	69	29	25	1237
10	165	84	250	176	108	90	128	53	330
11	-	-	-	-	-	-	30	27	30
12	-	-	-	-	-	-	-	-	137
13	-	-	-	-	-	-	-	-	39
14	-	-	-	-	-	-	-	-	NA
15	-	-	-	-	-	-	-	-	26
16[3]	-	-	-	-	-	-	-	-	NA
17	-	-	-	-	-	-	-	-	117
Yearly All-Site Mean	279	273	179	521	189	232	328[1]	193[1]	238[2]

[1] Data from Site 11 not included in the yearly all-site mean.

[2] Data from Sites 11 through 17 not included in the yearly all-site mean.

[3] Control Site. NA - Analytical results not available.

TABLE: 3 Chloride Content of Unwashed Grasses Collected Near The Canadian Salt Company Limited, Windsor 1979-1989

Survey Site Number	Chloride Concentration (percent - dry weight)								
	1979	1980	1981	1982	1983	1984	1985	1986	1989
1	0.4	0.5	0.4	0.8	0.9	1.8	1.5	1.1	1.6
2	0.3	1.6	0.9	0.5	0.8	0.6	1.1	0.3	0.8
3	0.4	0.4	0.3	0.2	0.7	1.1	1.5	1.2	0.6
4	0.2	0.8	0.9	0.7	0.8	1.2	0.8	0.6	0.8
5	0.4	NA	0.7	0.3	0.6	0.6	0.4	0.2	0.6
6	0.5	0.4	0.8	0.2	0.5	0.4	0.6	0.3	0.6
7	0.6	0.2	0.5	0.6	0.9	0.9	0.6	0.8	1.0
8	0.2	0.5	1.1	0.8	0.7	1.1	0.7	0.7	1.1
9	0.5	0.7	0.5	0.7	0.6	1.2	0.9	0.8	1.9
10	1.3	1.2	2.0	1.1	0.6	1.5	1.2	0.8	2.2
11	-	-	-	-	-	-	0.4	0.3	0.8
12	-	-	-	-	-	-	-	-	0.6
13	-	-	-	-	-	-	-	-	1.0
14	-	-	-	-	-	-	-	-	NA
15	-	-	-	-	-	-	-	-	0.8
16[3]	-	-	-	-	-	-	-	-	NA
17	-	-	-	-	-	-	-	-	1.2
Yearly All-Site Mean	0.5	0.6	0.8	0.6	0.7	1.0	0.9[1]	0.7[1]	1.1[2]

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[1] Data from Site 11 not included in the yearly all-site mean.

[2] Data from Sites 11 through 17 not included in the yearly all-site mean.

[3] Control site. NA - Analytical results not available.

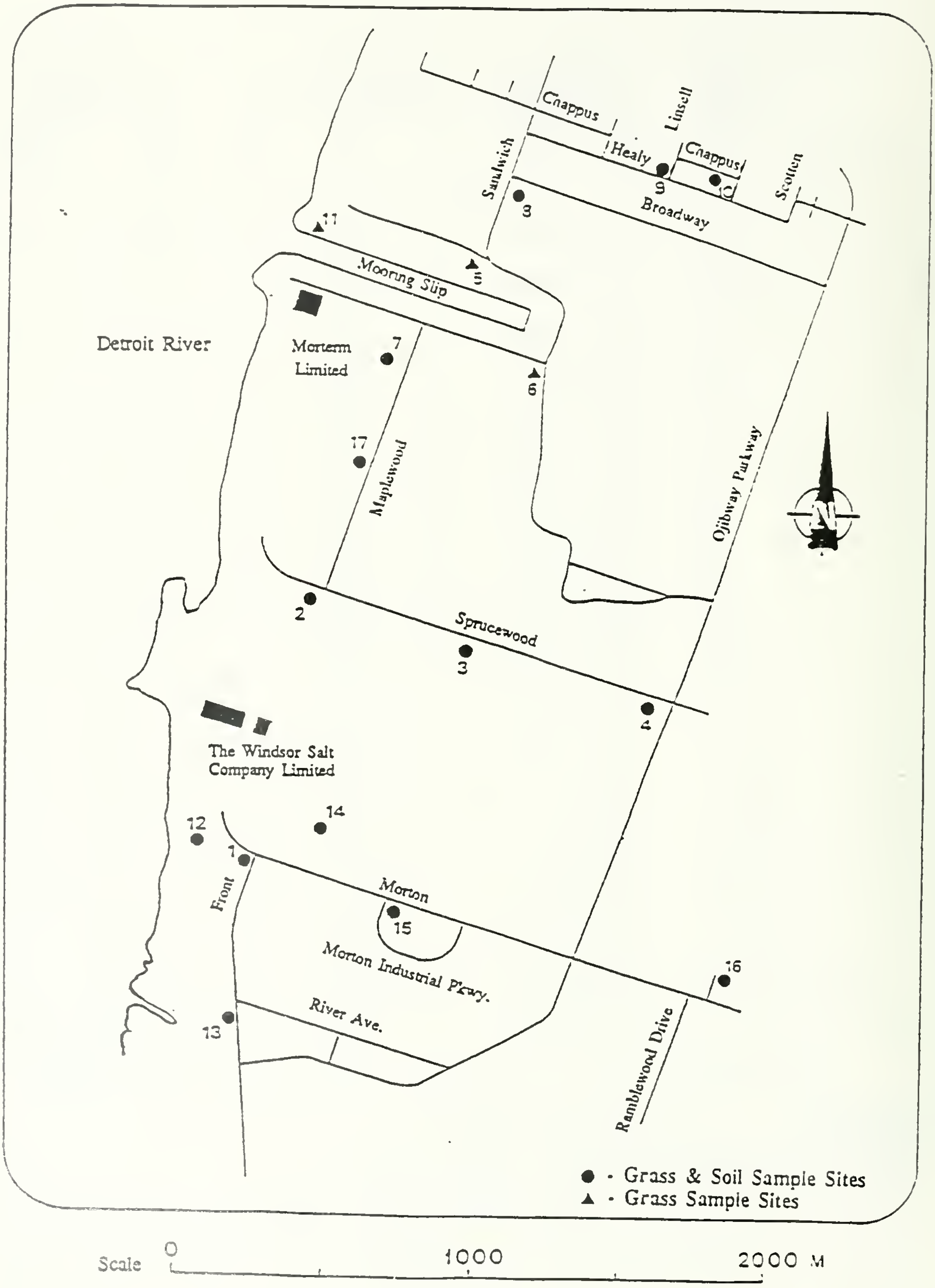
TABLE: 4 Sodium and Chloride Values Detected in 0-5 cm Soil Collected in the Vicinity of The Canadian Salt Company Limited, Windsor 1989

Survey Site Number	Direction & Approximate Distance from Salt Co.	Sodium (ppm - dry wt)	Chloride (ppm - dry wt)
1	0.6 km SSE	86	16
2	0.4 km NNE	90	15
3	0.8 km ENE	93	6
4	1.5 km E	52	13
5	1.6 km NE	NS	NS
6	1.5 km NNE	NS	NS
7	1.4 km NE	87	14
8	2.1 km NE	108	11
9	2.4 km NE	71	29
10	2.6 km NE	59	17
11	1.6 km NNE	NS	NS
12	0.5 km S	66	13
13	1.2 km S	36	12
14	0.6 km SE	52	27
15	1.2 km SE	32	18
16[1]	2.2 km ESE	66	9
17	1.0 km NNE	50	24

[1] Control Site. NS - No sample collected.

Each value is an average of triplicate sample analysis.

FIGURE: 1 Phytotoxicology Grass and Soil Surveillance Sites in the Vicinity of The Canadian Salt Company Limited, 1989



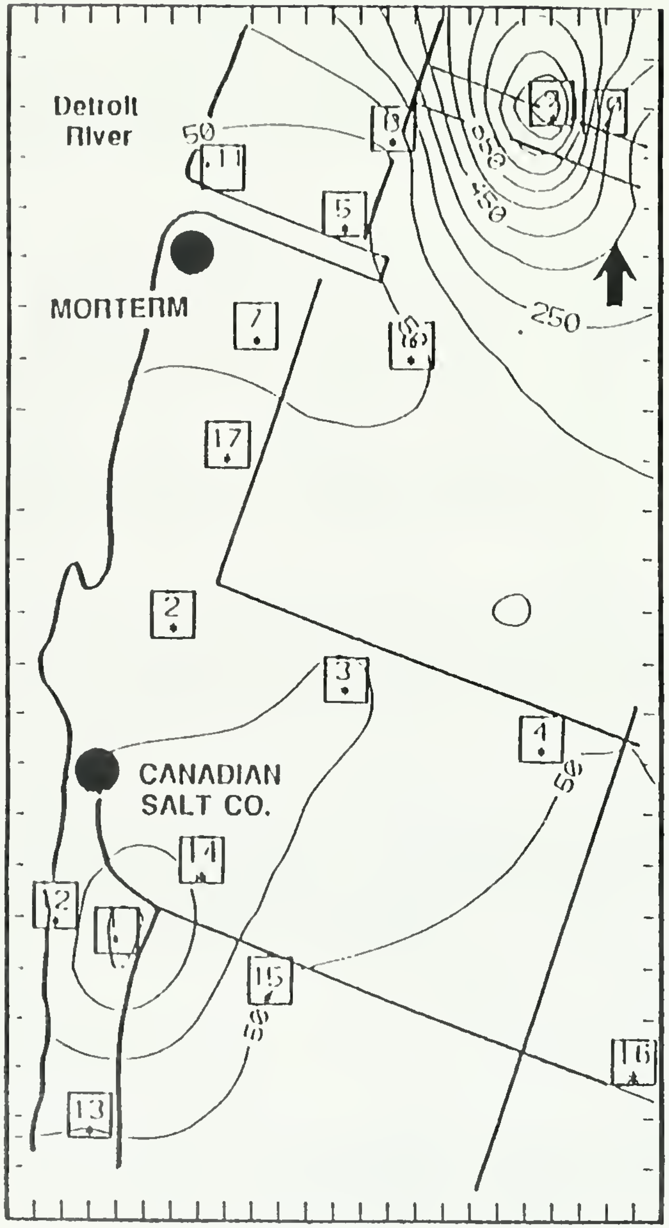


FIGURE: 2

Contour Map Showing Estimated Pattern of Sodium in Grasses in the Vicinity of The Canadian Salt Co. Ltd., Windsor

Contour Interval - 100 ppm

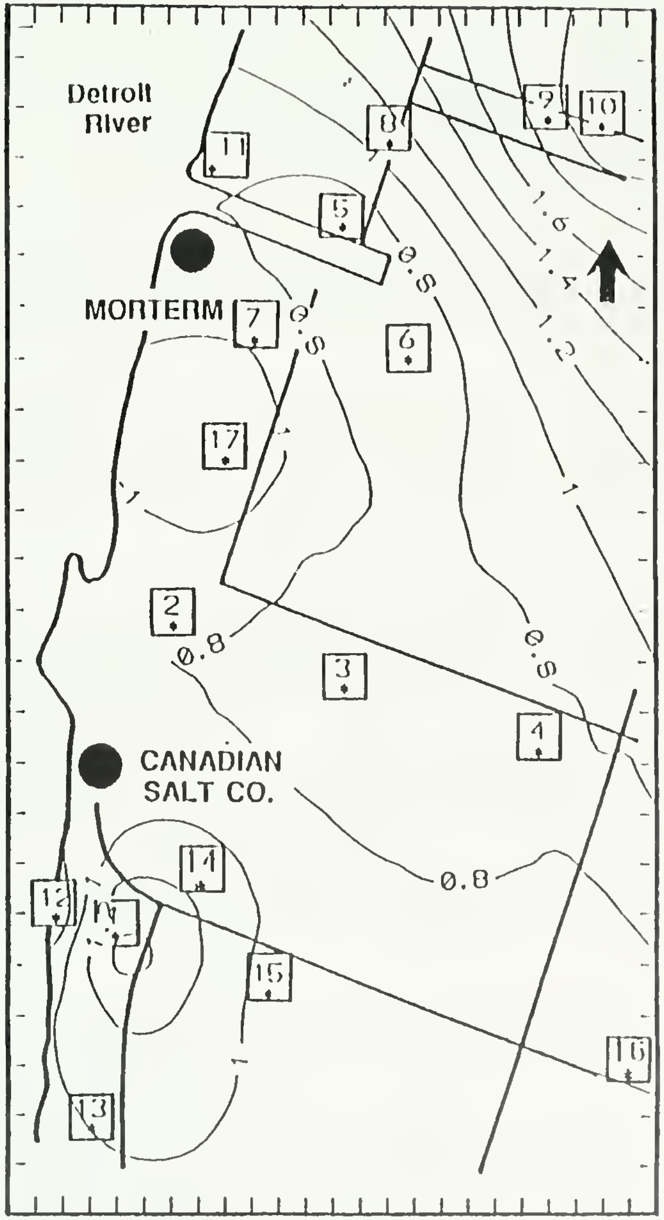
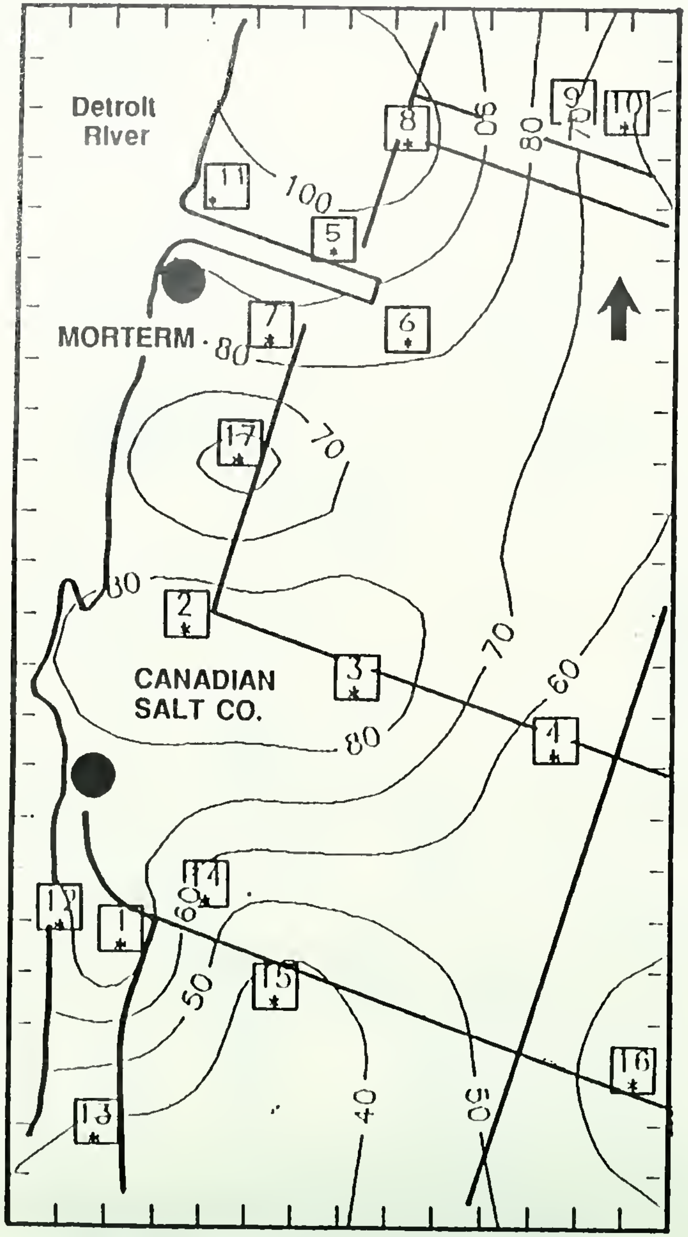


FIGURE: 3

Contour Map Showing Estimated Pattern of Chloride in Grasses in the Vicinity of The Canadian Salt Co. Ltd., Windsor

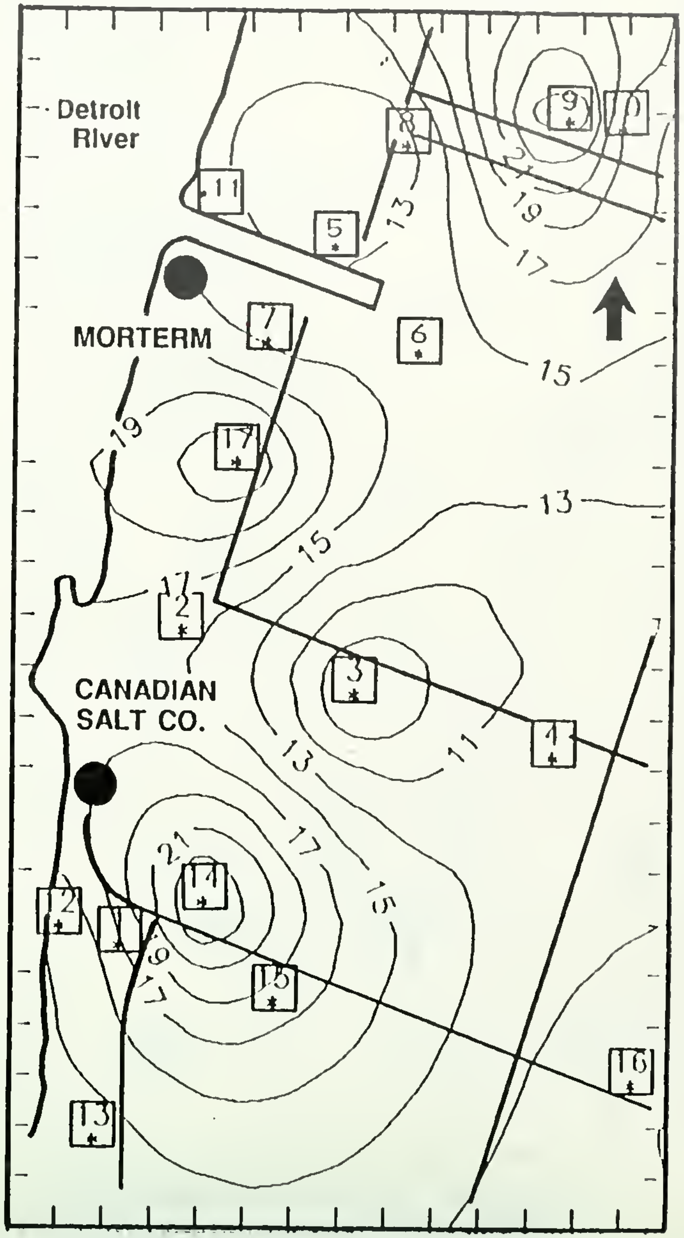
Contour Interval - 0.2%

FIGURE: 4
Contour Map Showing Estimated Pattern of Sodium in 0-5 cm Soil in the Vicinity of The Canadian Salt Co. Ltd., Windsor



Contour Interval - 10 ppm

FIGURE: 5
Contour Map Showing Estimated Pattern of Chloride in 0-5 cm Soil in the Vicinity of The Canadian Salt Co. Ltd., Windsor



Contour Interval - 2 ppm